

PROTYPING AND ANALYZING THE CONGESTION CONTROL FOR MULTICAST OVER 3G NETWORKS

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ABSTRACT

A large literature is there on congestion control and that is based on optimization and control theories in some recent year. First TCP friendly congestion control has been discussed, the classification criteria of TCP friendly congestion control has been analyzed like Network supported, end to end, unicast, multicast, single rate and multi rate. This paper provides an overview of optimization flow control, traces the development in a framework, from uni cast to multicast. A demand is growing for efficient multimedia streaming applications over the Internet. These new transport protocols could cause congestion collapse if they are widely used but do not provide adequate congestion control. The system models for multicast congestion control are evaluated, and then identify three key problems: feedback implosion, congestion indicator filtering and fairness.

KEYWORDS: Congestion Control, Multicast, Unicast, TCP-Friendly Implosion

I. INTRODUCTION

Network congestion occurs when a link or node is carrying so much data that its quality of service deteriorates. Networks using these protocols can exhibit two stable states under the same level of load. The stable state with low throughput is also known as congestive collapse. Multicast system also improves the efficiency of the data that has multipoint distribution. It builds a distribution tree from a sender to a set of receivers. By the increasing popularity of group communication applications has led to a great deal of interest in the development of multicast transport protocols layered on top of IP multicast. However, these new transport protocols could cause congestion collapse if they are widely used but do not provide adequate congestion control. The success of the Internet relies on the fact that TCP sessions respond to congestion by reducing their load presented to the network [1] [2].

TCP provides the reliable data transfer and also supports flow and congestion control. There are various schemes for congestion control for TCP. Some non TCP application are also present on internet which do not have congestion control mechanism and these application do not share bandwidth fairly with TCP based application.

Some unfairness has occurred because as the traffic from such TCP unfriendly application like IP telephony, video conferencing, audio conversations, online movies is increasing so there exists a need to solve this unfairness. TCP flow adjust their flow rate if somewhere congestion is detected but non TCP flow continue to send at same uncontrolled rate. Because since these have strict latency requirements than reliable delivery causing unfairness, and in worse case leading to congestion collapse [1].

Case of multicast is even worse as in this case different members of group may have different characteristics and also congestion level of receiver link can also be different. If a sender adjusts its sending rate for every loss indication by

receiver then its transmission rate will be completely throttled so there is a need to find a way to select most suitable receiver such that most congested path is selected and network bandwidth is utilized to maximum possible. In this paper we discuss different proposed TCP friendly congestion control schemes [1][4].

II. CLASSIFICATION CRITERIA

TCP friendly congestion control schemes can be classified based of the following criteria.

A. End to End and Network Supported

The classification in TCP friendly schemes can be done on basis of where the congestion control mechanism is implemented. As the name specifies from End to End handles the congestion control without relying on the network components just like routers here the sender adjust the data flow rate based on the feedback provided by the receiver.

Receiver decides what layers to join in layered approach for multi cast traffic as we will see later receiver can decide whether to join or leave layers depending upon its congestion status. It will also support congestion control by sending its feedback. End to End schemes are easy to implement compared to network supported schemes [1] [4].

Routers can detect congestion and send feedback to sender and sender can adjust its sending rate. Compared to end to end where sender keep pumping data at same rate till receiver's feedback is received network assisted congestion control can send indicator packets to its parent thus control starts before actual steps taken by senders.

B. Unicast and Multicast

Unicast sender sends data to only one receiver at a time thus congestion control for that connection solely depends upon network condition between sender and receiver. Non TCP flows support both unicast as well as multicast transfer. Compared to unicast multicast congestion control is hard to design since in this case sender has to decide how to adjust sending rate if multiple receiver are affected by congestion and sends their congestion indicators, if sender adjust its sending rate for every CI it receives then the transmission rate will be completely throttled, hence there is a need to select some representative or a way to filter out these indicator to select best among them [6][7][8].

This problem is further affected by the fact different receivers may have different bandwidth thus require different flow rates to fully utilize their available bandwidth so selecting the best possible congestion representative such that congestion problem is controlled and network resource are utilized to best possible is a prime need.

C. Single Rate Vs Multi-rate

At the point of definition, in single rate a sender send data at same rate to all the receivers. This approach limits the maximum transfer rate for all the receivers since all receivers will get data at same rate that is limited by the rate of bottleneck receiver, whereas in multi-rate a sender sends data at multiple rates.

In Multi-rate schemes the source maintains several layers each having different transmission rates, receivers depending upon their network bandwidth and congestion status can subscribe to different subset of layers. Care has to be taken while leaving or joining a multicast group for most effective congestion control [1][7].

III. SYSTEM MODEL

There are two types of control systems: feedback and open-loop according control theory. In a feedback control

system, the result of the control is measured and the control parameter is adjusted on the fly. In an open-loop control system, a pre-determined control strategy is fixed without adjustment on the fly [8][9].

However, the current Internet provides best effort service. Quality of service reservation using RSVP has not been widely deployed. Without service reservation, open-loop congestion control is difficult to implement.

Figure 1 shows our model of the feedback congestion control system.

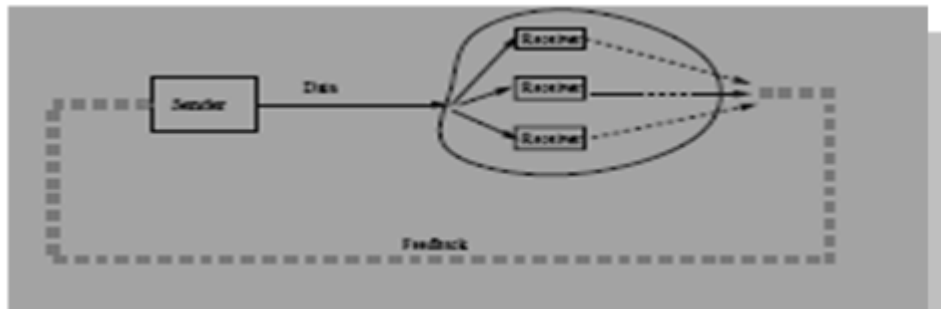


Figure 1: Congestion Control System Model

A sender congestion control component accepts data from its upper layer. It then uses the control parameter c to decide if it can put more data into the network. If so, it sends data to the receivers using IP multicast. It uses a thin solid line to represent each data path. Receivers will send feedbacks to the sender. The control parameter c should be adjusted according to network traffic conditions. We call the algorithm to estimate c the estimation algorithm [10][11][12].

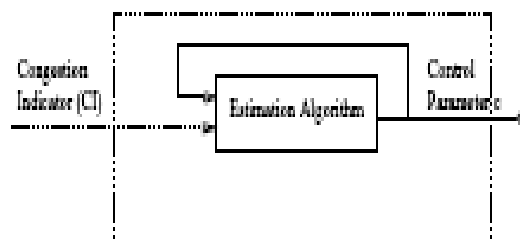


Figure 2: Estimation Algorithm System Model

- **Control Parameter**

The control parameter can be either window or rate. If it is a window, the sender can send any new data into the network whenever there exists space in the window. Otherwise, if the parameter is rate, the sender can inject new data no higher than the rate. The advantage of window control is that it integrates naturally with error control and flow control. Also, window control reacts to network changes faster [13][14].

The advantage of rate control is that it is a natural control parameter for certain applications, e.g. streaming media, which have intrinsic sending rates.

- **Placement of Estimation Algorithm**

The sender may not be the entity that runs the estimation algorithm. For scalability reasons, it can be more efficient for each receiver to run a local estimation algorithm, and send its estimation to the sender.

- **Congestion Indicator (CI)**

Selecting the right CI is always a difficult problem. The criteria for the selection of CI are:

- Is it a good indication of congestion?
- Is it easy to monitor?

Below 4 types of congestion indicators are discussed and many other types can also be designed. NACK/ ACK. The simplest CI is receiving (ACK) or missing (NACK) a packet. They are the easiest to monitor, and give the fastest response. Experience of TCP shows, that they work fine for unicast congestion control. However, ACK/NACK reflects only instantaneous network congestion status. Drop-tail router and traffic phase effects generate bursty packet loss. This type of congestion indicator estimates the number of packets queued in the network by estimating the change in round trip time (RTT). The advantage of this congestion indicator is that it can detect congestion before packet loss.

Loss Rate: One way to smooth the bursty NACK/ACK congestion indicator is to use loss rate. The difficulty is how to calculate the loss rate. If the calculation period is too short, it will still be bursty. If the calculation is over a longer period, the control will be less responsive [13].

Incoming Rate: Another way to smooth the bursty NACK/ACK is to measure the packet incoming rate. Congestion can be detected when the sender's sending rate is higher than the receiver's measured incoming rate. The difference between these two rates reflects the packet loss rate. However, calculating the incoming rate for bursty traffic is not straightforward.

4. Estimation Algorithm: The control parameter c will be continuously updated according to the received congestion indicator. In this paper, we define two specific types of estimation algorithms. Other types of estimation algorithms can be designed and should be explored.

IV. KEY PROBLEMS AND SOLUTION APPROACHES

With the above control model and terminology in mind, we next discuss the key problems and solution approaches.

A. Feedback Implosion Problem

The first problem facing multicast congestion control is the feedback implosion problem.

For a sender to adjust its control parameter according to network traffic, it must receive feedback from the receivers (we assume no explicit network congestion support) [9][10][15]. Therefore, we have to deal with the same feedback implosion problem as multicast error control. We identify two approaches to solve the feedback implosion problem:

- Suppression-based
- Structure-based.

Suppression: In this approach, not all receivers will send their feedbacks to the sender. One solution is to choose some receivers as representatives, and only the representatives send their feedbacks. The difficulty with this approach is how to select a suitable set of representatives. Another suppression approach is to adapt the SRM suppression algorithm

designed originally for reliable multicast error control. In this algorithm, receivers control their feedbacks using random timers. This adds the requirement that every receiver has to measure the distance.

Structure-Based: Another approach to solve the feedback implosion problem is to organize the receivers into a structure, and feedbacks are propagated and aggregated through the structure. MTCP [8], TFMCC [12], and Golestani [10][11] all proposed to use a tree hierarchy to aggregate feedback traffic.

B. Congestion Indicator Filtering Problem

The second problem is the congestion indicator filtering problem. Unlike TCP, which just needs to control the single connection between a sender and a receiver, multicast congestion control has to support a wide range of operating parameters for each connection. As the number of receivers increases, the range of suitable transmission rates diminishes. Several approaches have been proposed to filter the congestion indicator:

Representative: This approach is to solve the feedback implosion problem, will also reduce the impact of this problem. Because it has its congestion indicators that are restricted to be from only a small set of representatives, it reduces the impact of this problem. Further research includes, how to select the right size and right set of receivers as representatives needs further research.

Suppression Timer: In LTRC (Loss Tolerant Rate Controller), the sender will respond to only one loss report in a time period TD. The time TD is a measure of the time it takes for a rate change to “flush” through the system. The paper gives a method to determine TD. The difficulty of this approach is to make the tradeoff between responsiveness and the reduce-to zero problem. The effectiveness of this approach still needs further study.

C. Fairness Problem

Multicast congestion control has one more difficulty that is the fairness problem. In the last couple of years, one key challenge in multicast congestion control is the lack of a definition for fairness.

In the first section, several types of fairness: max-min fairness, and global resource fairness has been discussed [9]. Over the last years TCP has become the standard transport protocol as well as the widely used protocol (90-95% of the bytes or packets) in the Internet. For this reason, it has been strongly argued that multicast congestion control should be TCP-friendly. One seemingly obvious way to achieve this objective is to use the TCP congestion indicator (NACK/ACK) and estimation algorithm (AIMD algorithm) to do multicast congestion control. We have shown this will lead to very low throughput. So far, two approaches show promise to solve both of the congestion indicator filtering problem and the fairness problem.

Golestani's Approach: In this approach, the congestion indicator is still the NACK/ACK. However, to avoid the congestion indicator filtering problem, it is not the sender but each receiver that runs its own copy of estimation algorithm [15]. Therefore, it solves the congestion indicator filtering problem. The problem with this approach is that no specific estimation algorithm has been described. Also there is still no experimental validation yet.

TCP-formula Approach: The main and basic idea about this approach is very similar to golestani's approach. The individual receiver always implements the estimation algorithm. However, in this case, the rate was proposed instead of window control. With the help of these feedbacks from receivers, the sender will select the minimum of the rates and adjust its sending rate. The main disadvantage behind this approach is that, each of the receiver will measure both the

control parameters like loss rate and round trip time. As we previously discussed, in these measurements, a tradeoff between responsiveness and accuracy must be made in these measurements [10][14].

V. CONCLUSIONS

In this paper TCP friendly congestion control mechanism has been widely analyzed and discussed. This paper discusses the wide range of problems and evaluation mechanisms in the field of congestion in mobile network. Making TCP friendliness is because, the internet non-TCP flows competes with TCP one. This paper also Covered schemes for unicast and multicast traffic, also a survey for the different types of congestion control mechanism applying congestion based on different traffic need single rate for uniform sending rate and multi rate schemes for multiple sending rates. Various schemes have been proposed in these recent years and more work is still in progress. In this paper, identified 3 key problems and discussed the current prototyped solutions.

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